Australian Government

CTPCO
CRITICAL TECHNOLOGIES POLICY COORDINATION OFFICE

Photovoltaics

Devices that convert solar energy into electricity using layers of semiconductor materials.

Key Sectors

Impacts all sectors, including:

- Agriculture, Forestry and Fishing
- Banking and Finance
- Communications
- Construction
- Defence and Defence Industry
- Energy and Environment
- Health
- Manufacturing
- Mining and Resources
- Space
- Transport and Logistics

Estimated impact on national interest	Low	Med	High
Economic Prosperity			X
National Security	X		

Key Australian Government Actions

Initiatives

- Australian Renewable Energy Agency (ARENA)
- Clean Energy Finance Corporation (CEFC)
- Emissions Reduction Fund
- Energy Reporting Scheme
- Australian National Registry of Emissions Units (ANREU)
- Large-scale Renewable Energy Target
- Small-scale Renewable Energy Scheme
- Kidston Pumper Hydro Energy Storage

Regulations

- Clean Energy Regulator Act 2011

Example Outcomes

- Diversified electricity grid and energy supply
- Improved access to cheap, effective renewable energy and increased uptake in solar technology
- Capability to power remote devices without the need for centralised electricity
- Direct powering of electric vehicles
- Financial benefits to consumers from self-generation of solar power
- Financial benefits to agricultural producers from biodiversity stewardship options
- Improved water management in arid areas using floating solar farms

Underpinning Science

ANZ Standard Research Classification

- Electronics, sensors and digital hardware
- Electrical engineering
- Materials engineering

Example Applications

Readiness Level – Now

- Rooftop solar PV systems for homes and businesses
- Large scale solar farms
- Silicon PV cells integrated into building cladding and roof tiles
- Solar-powered un-crewed aerial vehicles with extended endurance
- Solar-powered spacecraft and the international space station powered by solar arrays
- Floatvoltaics – floating solar panels placed on bodies of water, estimated to be 8-10% more efficient than land-based variants

Readiness Level – 2–5 years

- Third generation perovskite solar cells that generate 30% more electricity than conventional solar cells
- Solar sail technology for low-cost deep space missions
- Solar skins – allows for the custom display of images by allowing light to filter through a panel
- Solar fabrics – fabrics that can be bent or glued on any surface and are ten times lighter than framed panels

Readiness Level – Beyond 5 years

- Transparent quantum dot or organic PV cells integrated into windows and skylights
- Highly efficient photovoltaic/thermal systems that convert sunlight into electricity and also store the excess thermal energy produced
- Indoor photovoltaics to power internet of things devices from ambient light inside buildings

Australia's place in the world

Australia ranks 7th for research impact, led by the Australian National University in 4th place internationally. Australia also has 3 other research institutions ranked in the world's top 50. China leads research and has 4 research institutions in the top 10, followed by the United States in 2nd place. Australia has 2 institutions in the international top 10 institutions for research impact.

Venture capital (VC) investment in photovoltaics has been increasing at around 5% p.a. since 2016, with the United States having significant amounts of VC investment, well ahead of Norway, Canada, Germany and France, while Australia is ranked 15th. Australia is also ranked 15th for patents for photovoltaics, which is led by China with approximately 2.5 times the number of patents compared to 2nd ranked United States.

Given the abundance of solar radiation throughout Australia, we have a competitive advantage in this area, particularly since we have world-leading research and are an attractive destination for capital investment. As photovoltaic cells become cheaper and more efficient, Australia could compete more effectively for energy intensive industry and advanced manufacturing including food, iron, steel, aluminium, paper and chemical production. PV can also support other key technologies such as hydrogen production.

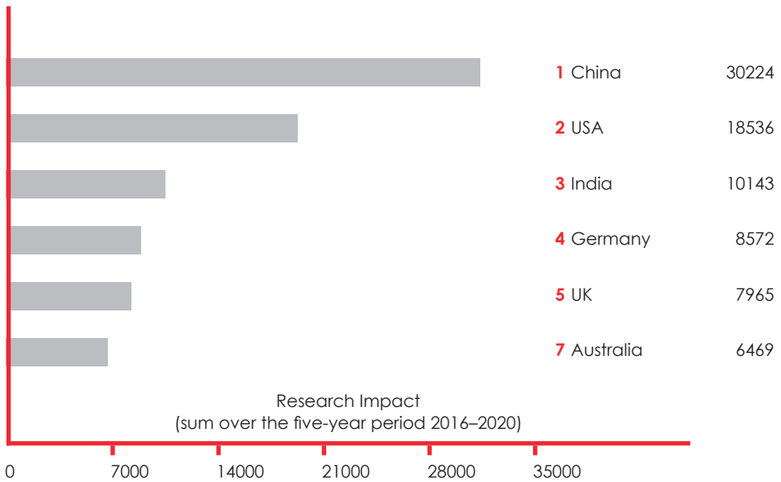
Opportunities and Risks

Photovoltaic (PV) technology presents Australia with enormous opportunities and harnessing PV could provide Australia with a cost-effective way to meet our emission reduction targets. In 2021, Australia committed to a national goal of net zero emissions by 2050 ahead of the 2021 UN Climate Change Conference (COP26) in Glasgow. One key technology expected to help Australia reach net zero emissions is 'ultra-low-cost solar'. Australia is ideally placed to meet our emissions commitments through PV using our environmental advantages, leveraging our strong research sector and supporting pathways for venture capital investment. Investment in solar power is becoming increasingly affordable, both for households and on a broader scale. Australia has the highest solar radiation per unit area of any continent, giving us abundant supplies of renewable energy. Specifically, producing solar panels more efficiently through further innovation in quantum dot cells could result in order-of-magnitude reductions in greenhouse-gas emissions. In 2020–21, Solar PV generated approximately 10% of Australia's electricity and remains the fastest growing generation type in Australia.

Despite Australia's advantages in this area challenges remain, in particular, domestically, the best solar resources are in parts of Australia with the least electricity network coverage, hence the need for increased electricity transmission capability. Since PV electricity production is inherently linked with the availability of sunlight, supply fluctuates with the weather and time-of-day. In order to facilitate a stable supply of PV generated electricity to the grid, sophisticated (and as yet undeveloped) technology is required. Storage of renewable energy (including PV) remains expensive for both battery creation and storage costs, however this cost is expected to decrease as these technologies advance. The manufacture and disposal of solar panels is an additional environmental concern, however there is increasing focus on developing end of life disposal and management to combat this issue. To fully leverage the benefits offered by PV, Australia needs to advance complementary technologies and policies associated with supply, storage, manufacturing and disposal concerns.

Research Impact (RI)

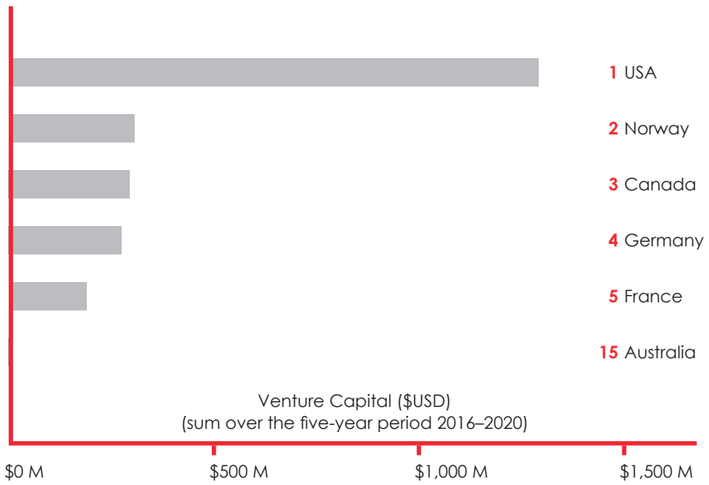
China has the highest research impact in this area, ahead of the United States. Australia is ranked 7th. Total volume of published research has been increasing at 7% p.a. over the 5 year period 2016–2020, with 27% of research involving international collaboration.



The research impact provides an indication of the productivity of a country or institution. Here, productivity was assumed to be represented by the volume of publications (i.e. scholarly output) as an indicator of the resources & facilities, and the level of interest in the publications as an indicator of quality.

VC Investment

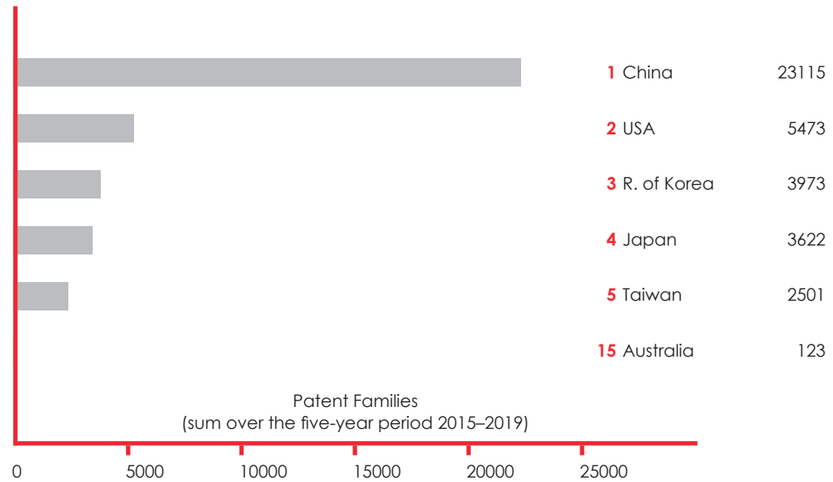
The United States has significantly higher amounts of VC investment, well ahead of Norway, Canada, Germany and France, while Australia is ranked 15th for VC investment in photovoltaics. Investment in this area has been growing at 5% p.a. since 2016.



Data from Crunchbase. The Crunchbase database provides a partial view of the global VC landscape. However the quantity, quality and richness of the data are considered to be statistically significant, and indicative of global trends.

Patents - International

The number of patents being lodged annually in this field has been decreasing by around 1% p.a. since 2015. Most patents in this field were filed by applicants or inventors from China. Australia is ranked 15th.



Research Institutions - International

China has 4 institutions in the top 10 international institutions, and Australia has two. Institutions from France, Germany, the United States and the United Kingdom make up the remainder of the top 10.

Rank	Top International Institution	Research Impact
1	Chinese Academy of Sciences | China	6227
2	French National Centre for Scientific Research (CNRS) | France	2968
3	Helmholtz Centre Berlin for Materials and Energy | Germany	2931
4	Australian National University | Australia	2677
5	National Renewable Energy Laboratory | United States	2473
6	University of New South Wales | Australia	2459
7	University of Chinese Academy of Sciences | China	2284
8	University of Oxford | United Kingdom	2225
9	Peking University | China	2152
10	Huazhong University of Science and Technology | China	2101

Research Institutions - Australia

The top 4 ranked Australian institutions are ranked in the top 50 international institutions for research impact. The top ranked Australian National University is ranked 4th internationally, and the University of New South Wales is ranked 6th internationally.

Rank	Top Australian Institution	Research Impact
1	Australian National University	2677
2	University of New South Wales	2459
3	University of Melbourne	1578
4	Monash University	866
5	University of Sydney	418
6	Swinburne University of Technology	370
7	Royal Melbourne Institute of Technology University	355
8	University of Queensland	345
9	University of Western Australia	334
10	Queensland University of Technology	304

Patents - Australia

Top Australian Patent Applicants	Patent Families
NewSouth Innovations	26
CSIRO	5
Australian National University	4
Clearvue Tech Ltd	3
A number of Australian businesses have less than 3 patent families recorded in this technology area	

Patents filed by Australian businesses, 2015–2019.

Data current as at 16 March 2022.